SUMMARY OF AIR QUALITY MONITORING IN ALBERTA 1992

Alberta
ENVIRONMENTAL PROTECTION

SUMMARY OF AIR QUALITY MONITORING IN ALBERTA 1992

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This report is one in a series of air quality annual reports produced by Alberta Environmental Protection for 1992. The following air quality annual reports are available for 1992:

Summary of Air Quality Monitoring in Alberta: 1992.
Air Quality Monitoring Report for Alberta: 1992 - Technical Report Series No. 93-2a.
Air Quality Monitoring Data Summary for Alberta: 1992 - Technical Report Series No. 93-2b.

For copies of these reports or for more information contact:

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OVERVIEW

The issue of air quality and its effects on the environment has received a great deal of attention over the past decade. Alberta Environmental Protection is committed to monitoring air quality and reporting air quality information to the public. A comprehensive air quality network which monitors for 17 major air pollutants is currently operated by Alberta Environmental Protection. This network consists of 9 continuous stations, 7 intermittent stations, over 250 static stations and 12 acid precipitation stations. This report is a summary of the information collected by the air quality monitoring program in 1992.

Alberta Environmental Protection uses an air quality index to relate Good, Fair, Poor and Very Poor air quality categories to provincial and federal objectives. Outdoor concentrations of carbon monoxide, the coefficient of haze (dust and smoke), nitrogen dioxide, ozone and sulphur dioxide are used to determine this index. Continuous monitoring stations are located in Edmonton (3 stations), Calgary (3 stations), Fort Saskatchewan, Fort McMurray and Fort MacKay.

In 1992, the air quality was Good over 85% of the time at all Alberta Environmental Protection air quality monitoring stations. The highest frequency of Good air quality readings was at the Fort McMurray station where the air quality index was Good 99% of the time. Fair air quality was most frequent at the Edmonton northwest station (13% of the time). The air quality index was in the Poor range 1.3% of the time at the Edmonton northwest station. Poor air quality was reported less than 1% of the time at the remaining stations. A Very Poor air quality episode was reported at the Edmonton northwest station for one hour from 6 a.m. to 7 a.m. on September 29, 1992. This episode was caused by the combination of vehicle exhaust emissions with a strong temperature inversion which persisted in the early morning hours. No other Very Poor air quality episodes were reported in 1992.

Based on seven years of data, a statistically significant trend towards a higher frequency of Good air quality was observed at the Calgary downtown station. No significant trends in the air quality index were evident at any other air quality stations.

Annual average pollutant concentrations in 1992 were significantly lower than the long-term average at most stations for carbon monoxide, dust and smoke (the coefficient of haze), suspended particulates, Benzo (a) Pyrene and lead. Annual average concentrations in 1992 were greater than the long-term average at the: Edmonton central station (hydrocarbons); Edmonton east station (coefficient of haze and nitrogen dioxide); Fort Saskatchewan station (nitrogen dioxide and hydrocarbons); and the Fort McMurray station (carbon monoxide and the coefficient of haze).

The 1-hour regulation for ozone was not exceeded at any stations in 1992. However, as in previous years, the 24-hour regulation for ozone was exceeded at all monitoring stations. These exceedances are primarily due to natural ozone generating processes such as: (1) the photochemical reaction of sunlight with naturally occurring oxides of nitrogen and volatile organic compounds; and (2) the transport of ozone from the upper atmosphere to ground level. Exceedances of the 24-hour regulation were less frequent in downtown Edmonton and Calgary than at smaller urban centres such as Fort Saskatchewan and Fort McMurray. Higher 24-hour average ozone concentrations in smaller urban centres are largely due to ozone that is generated naturally in the background atmosphere.

This background or rural ozone is transported into urban centres and is destroyed by nitric oxide that is predominantly emitted by automobiles. The net result of this process is lower ozone concentrations in the downtown cores of Edmonton and Calgary.

Air pollutants such as carbon monoxide, dust and smoke (the coefficient of haze), oxides of nitrogen, some hydrocarbons, suspended particulates, Benzo (a) Pyrene and lead were generally higher at urban air quality stations that are located close to major traffic arteries. Concentrations of these pollutants were generally greater during morning and afternoon rush hours and during the fall and winter seasons. This is due to increased emissions from vehicles during the rush hour in combination with stagnant weather conditions which occur more frequently during the fall and winter.

Regulations for carbon monoxide were exceeded at the Edmonton central, Edmonton northwest and all Calgary stations. A downward trend in carbon monoxide concentrations is evident at all of these monitoring stations as well as the Fort McMurray station. This trend can be related to more efficient automobiles. The guideline for the coefficient of haze (dust and smoke) was not exceeded in 1992. A slight decrease in annual average coefficient of haze values is apparent at the Calgary residential and Fort Saskatchewan monitoring stations while a slight increase in noted at the Edmonton east station. As in previous years, the annual average regulation for nitrogen dioxide was exceeded at the Calgary downtown station in 1992. However, this value was 16% lower than the long-term annual average for nitrogen dioxide. A downward trend in annual average nitrogen dioxide values is evident at the Edmonton central monitoring station.

Significant downward trends in suspended particulate loadings are apparent at all Calgary stations, the Edmonton northwest and central stations, as well as the Fort Saskatchewan station. The 24-hour regulation for suspended particulates was exceeded occasionally at all stations. The major sources of these suspended particulates are vehicle exhaust, road dust, wind-blown soil and industrial emissions.

A substantial downward trend in lead loadings is evident at all air quality stations. For example, lead loadings at Edmonton and Calgary stations in 1992 were less than 10% of the long-term average. The decrease of lead in the atmosphere over the last decade is due to a general decrease in the use of leaded gasoline during the 1980s and the suspended sale of leaded gasoline in 1990. Benzo (a) Pyrene, which is a component of vehicle exhaust and smoke, also recorded annual average loadings in 1992 that were significantly less than the long-term average.

Carbon dioxide is monitored in downtown Calgary and at the Springbank Airport (20 km west-northwest of downtown Calgary). Concentrations of carbon dioxide observed at these locations were higher then those recorded at Crossfield, situated 40 km north of Calgary. Higher values in downtown Calgary can be attributed to the combustion of fossil fuels.

Regulations for hydrogen sulphide and sulphur dioxide, which are primarily emitted by the petrochemical and oil and gas industries, were exceeded on occasion at Alberta Environmental Protection monitoring stations. Exceedances of the regulations for hydrogen sulphide were reported

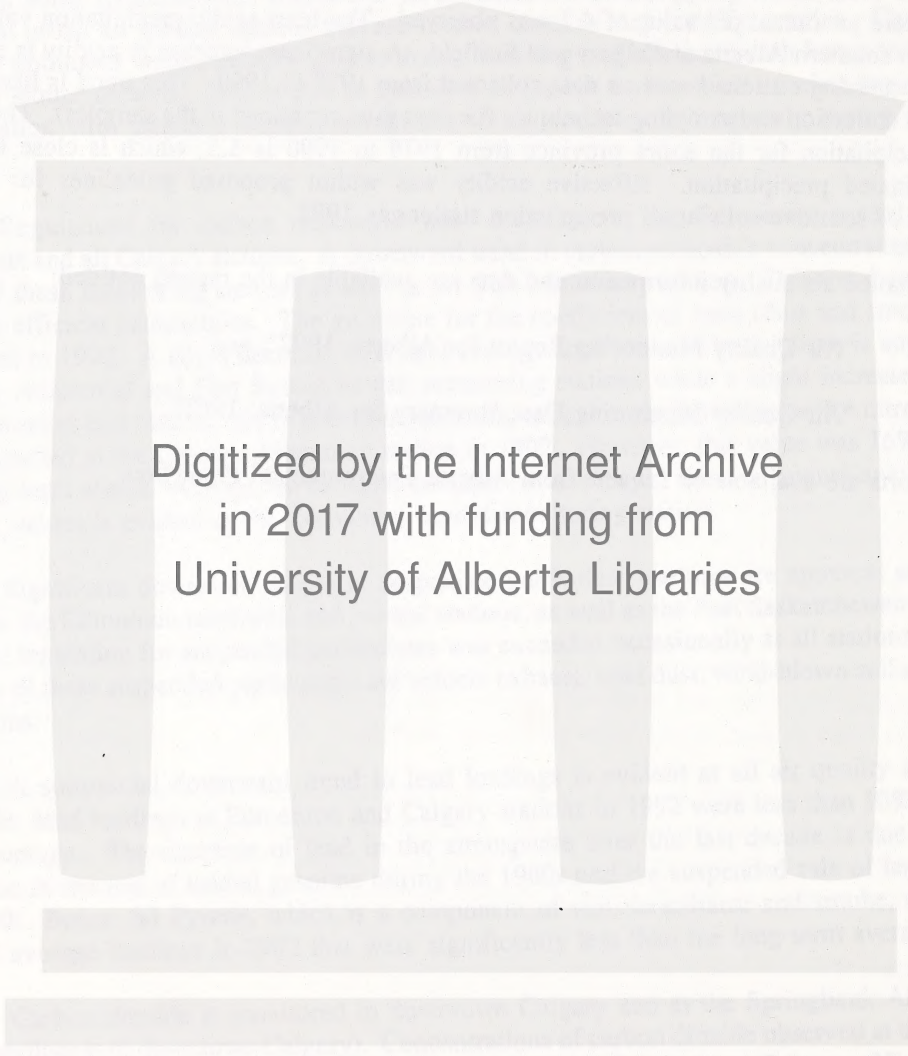
most frequently at the Edmonton east and Fort Saskatchewan stations. Exceedances at the Edmonton east station were much less frequent than those observed in 1991 (i.e. 11 in 1992 compared to 59 exceedances of the 1-hour regulation in 1991). The 1-hour regulation for sulphur dioxide was exceeded one time at the Fort MacKay station in 1992.

The most acidic precipitation in 1992 was recorded at the Fort McMurray precipitation station where an annual pH value of 4.7 was observed. The least acidic precipitation values were reported in southern Alberta at Calgary and Suffield. A significant increase in acidity is evident at several monitoring stations based on data collected from 1978 to 1990. This trend is likely due to better data collection and sampling techniques (i.e. less dust contained in the samples). The average pH in precipitation for the entire province from 1978 to 1990 is 5.5, which is close to that of uncontaminated precipitation. Effective acidity was within proposed guidelines for adequate protection of sensitive soils at all precipitation stations in 1992.

Detailed air quality information and data are available in the reports entitled:

- "Air Quality Monitoring Report for Alberta: 1992"; and
- "Air Quality Monitoring Data Summary for Alberta: 1992".

These reports are available on request from Alberta Environmental Protection.



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ABBREVIATIONS

IQUA - index of the quality of the air

O_3 - ozone

CO - carbon monoxide

CO_2 - carbon dioxide

COH - coefficient of haze

NO_2 - nitrogen dioxide

SO_2 - sulphur dioxide

H_2S - hydrogen sulphide

THC - total hydrocarbons

NH_3 - ammonia

TSP - total suspended particulates

BaP - Benzo (a) Pyrene

Pb - lead

UNITS OF MEASUREMENT

ppm - parts per million by volume

ppb - parts per billion by volume

ug/m^3 - micrograms per cubic meter

ug/1000 m^3 - micrograms per 1000 cubic meters

mg SO_3 equivalent/day/100 sq cm - milligrams of SO_3 per day per 100 square centimeters

mg/100 sq cm/30 days - milligrams per 100 square centimeters per 30 days

ug water soluble fluorides/100 sq cm/ 30 days - micrograms of water soluble fluorides per 100 square centimeters per 30 days

SUMMARY OF AIR QUALITY MONITORING IN ALBERTA: 1992

INTRODUCTION

In the early 1960s, the province began air quality monitoring at one station located in downtown Edmonton. By the mid 1970s, two more stations were added in Edmonton and by the end of the 1970s three stations were established in Calgary. In addition, air quality stations were installed at Fort McMurray, Fort MacKay and Fort Saskatchewan by the early 1980s. Today, a comprehensive network of 9 continuous stations, 7 intermittent stations, over 250 static stations and 12 acid precipitation stations make up the Alberta Environmental Protection air quality monitoring program. The objectives of the air quality monitoring program are to:

- *provide data for the assessment of existing air quality relative to regulations and objectives;*
- *inform the public on the status of air quality;*
- *monitor air quality in representative urban environments to document human exposure to air pollution;*
- *report long-term trends in air quality; and*
- *undertake monitoring in special problem areas.*

Air quality is an issue that is difficult to assess unless it is put into terms of a single, easily comprehensible indicator. The *I*ndex of the *QU*ality of the *A*ir (IQUA), developed by a federal-provincial committee in 1978, has been adopted by Alberta as well as other Canadian provinces.

THE INDEX OF THE QUALITY OF THE AIR (IQUA)

The IQUA relates concentrations of five major pollutants to a common scale which may be easily interpreted by the public. This scale associates Good, Fair, Poor and Very Poor air quality categories with provincial and federal air quality objectives. Outdoor concentrations of carbon monoxide, the coefficient of haze (dust and smoke), nitrogen dioxide, ozone and sulphur dioxide are used to determine the IQUA. The IQUA is updated twice daily (8:15 a.m. and 3:15 p.m.) at Edmonton and Calgary. The index telephone number is 427-7273 in Edmonton and 250-2099 in Calgary. In addition, the IQUA is reported by MacLaren Plansearch on The Weather Network.

The IQUA is calculated each hour at all Edmonton, Calgary, Fort Saskatchewan and Fort McMurray monitoring stations. The air quality index was in the Good category over 85% of the time at all Alberta Environmental Protection monitoring stations in 1992. The highest frequency of Poor air quality ratings was at the Edmonton northwest station (1.3% of the time). Poor air quality was reported less than 1% of the time at the remaining air quality stations. A Very Poor air quality episode was observed from 6 a.m. to 7 a.m. on September 29 at the Edmonton northwest station. This episode was caused by the combination of vehicular emissions with a very strong temperature inversion which persisted during the early morning hours limiting pollutant dispersion. Elevated levels of dust and smoke, carbon monoxide, oxides of nitrogen and total hydrocarbons were reported during this episode. The primary source of these pollutants is vehicle emissions.

IQUA rating	Frequency in Alberta	Effects
Good	almost all the time	Desirable range: no known harmful effects to soil, water, vegetation, animals, materials, visibility or human health. The long-term goal for air quality in Canada is to be in this range all the time.
Fair	occasional (typical when weather conditions inhibit pollutant dispersion)	Acceptable range: adequate protection against harmful effects to soil, water, vegetation, animals, materials, visibility and human health.
Poor	very seldom	Tolerable range: not all aspects of the environment are adequately protected from possible adverse effects. Long-term control action may be necessary, depending on the frequency, duration and circumstances of the readings.
Very Poor	very rare	Intolerable range: at this range, further deterioration of air quality and continued high readings could pose a risk to public health.

No other Very Poor air quality episodes were reported at Alberta Environmental Protection monitoring stations in 1992.

The pollutants responsible for the IQUA ratings are largely dependent on the location of the monitoring station relative to the pollutant sources. Dust and smoke (the coefficient of haze) is the most common cause of Fair, Poor and Very Poor air quality occurrences at air quality stations located near major traffic arteries or industrial sources. Ozone is the dominant pollutant at stations with less influence from vehicle traffic (i.e. Calgary residential and Fort McMurray). Carbon monoxide from vehicle exhaust occasionally is responsible for Fair air quality ratings at the Edmonton central, Calgary downtown and Calgary residential stations.

CONTINUOUS AIR QUALITY MONITORING

Air pollutants such as ozone, carbon monoxide, carbon dioxide, the coefficient of haze, nitrogen dioxide, sulphur dioxide, hydrogen sulphide, total hydrocarbons and ammonia are monitored continuously by Alberta Environmental Protection. Hourly average concentrations of these pollutants are reported once every hour, 24 hours a day, 365 days a year.

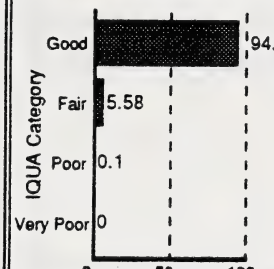
Ozone (O_3)

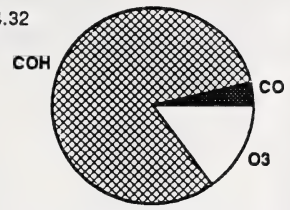
At normal outdoor concentrations, ozone is a colourless, odourless gas. However, ozone does have a characteristic sharp odour when at very high concentrations, such as that associated with lightning storms. Unlike many other pollutants, ozone is not emitted

THE INDEX OF THE QUALITY OF THE AIR

Edmonton 427-7273
Calgary 250-2099

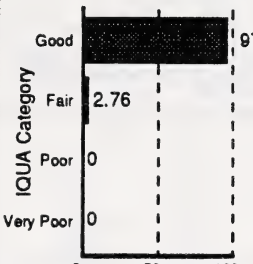
Edmonton Central

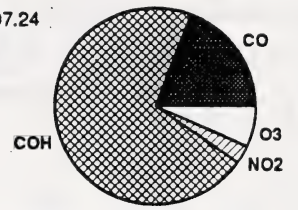




Relative Contribution of Pollutants to the IQUA during Fair, Poor and Very Poor Air Quality

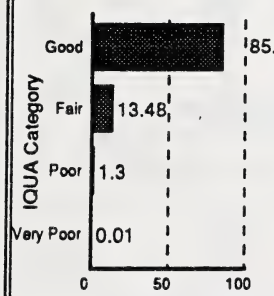
Calgary Downtown

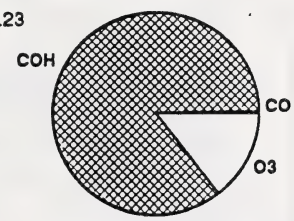




Relative Contribution of Pollutants to the IQUA during Fair, Poor and Very Poor Air Quality

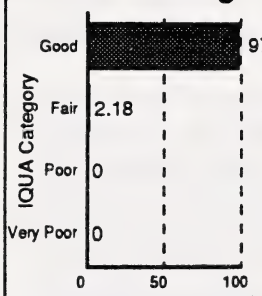
Edmonton Northwest

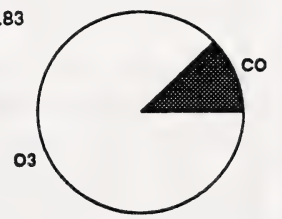




Relative Contribution of Pollutants to the IQUA during Fair, Poor and Very Poor Air Quality

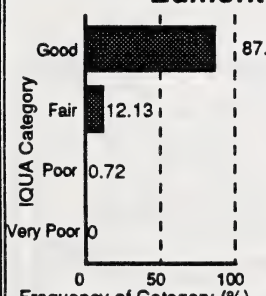
Calgary Residential

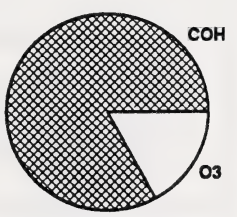




Relative Contribution of Pollutants to the IQUA during Fair, Poor and Very Poor Air Quality

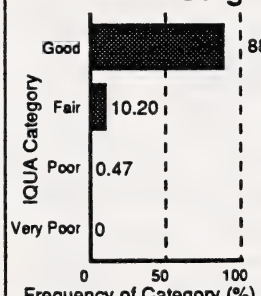
Edmonton East

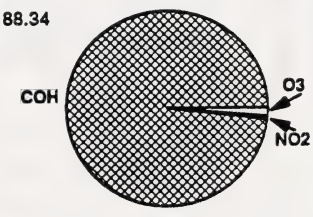




Relative Contribution of Pollutants to the IQUA during Fair, Poor and Very Poor Air Quality

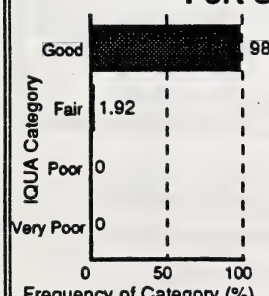
Calgary Industrial

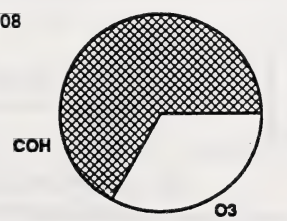




Relative Contribution of Pollutants to the IQUA during Fair, Poor and Very Poor Air Quality

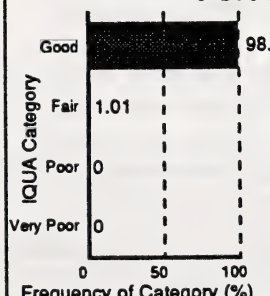
Fort Saskatchewan

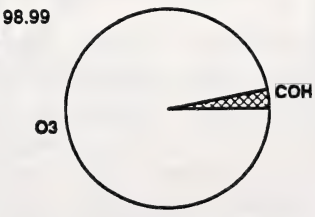




Relative Contribution of Pollutants to the IQUA during Fair, Poor and Very Poor Air Quality

Fort McMurray





Relative Contribution of Pollutants to the IQUA during Fair, Poor and Very Poor Air Quality

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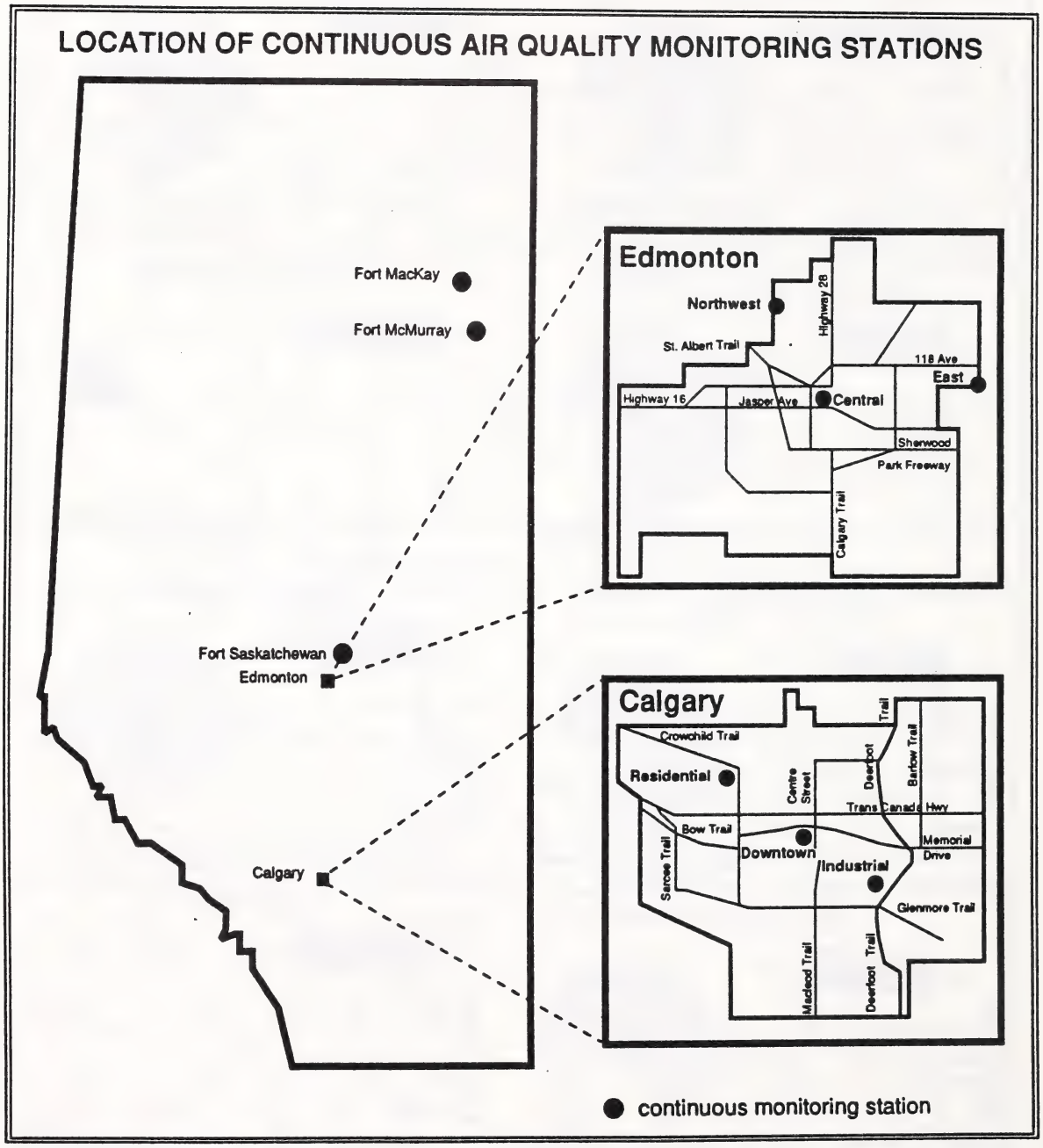

Alberta

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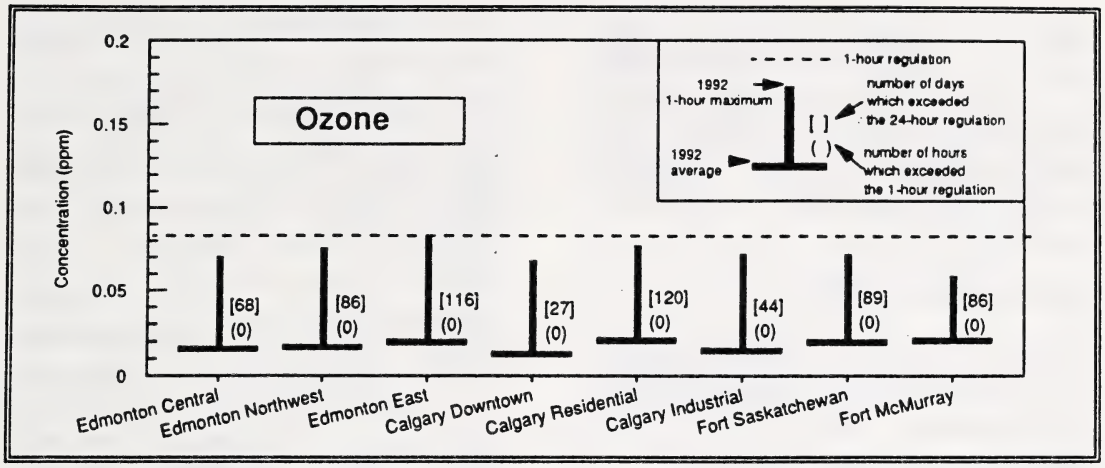


directly by man's activities, but is generated by a photochemical reaction between ultra-violet light from the sun with oxides of nitrogen (NO_x) and volatile organic compounds (VOCs). Residual nitrogen dioxide produced by this reaction may then be transported downwind and react with sunlight to form ozone and other photochemical pollutants. Ozone is also transported to ground level from the upper atmosphere by natural meteorological mixing processes. Ozone and ozone precursors, such as NO_x and VOCs, may also be carried from upwind sources such as urban centres and industrial complexes. A major source of VOCs in rural areas is natural emissions from trees and vegetation. In Alberta, ozone concentrations are generally higher at rural locations than at urban locations. This is due to the destruction of ozone by nitric oxide that is emitted by automobiles.

The regulations for ozone are as follows:

- *0.082 ppm as a 1-hour average concentration; and*
- *0.025 ppm as a 24-hour average concentration.*

The 1-hour regulation for ozone was not exceeded at any monitoring stations in 1992. As in previous years, the 24-hour regulation was exceeded at all monitoring stations. The vast majority of the exceedances of the 24-hour regulation are due to natural ozone generating processes such as: (1) the reaction of sunlight with naturally occurring hydrocarbons and oxides of nitrogen; and (2) the transport of ozone from the upper atmosphere. The most exceedances of the 24-hour regulation were recorded at the Calgary residential and Edmonton east stations where 120 and 116 days had ozone concentrations greater than 0.025 ppm, respectively. Exceedances of the 24-hour regulation were recorded most frequently in the Spring at all monitoring stations. The 24-hour regulation for ozone is often exceeded at pristine locations in Alberta.

Ozone concentrations reached a maximum during the spring and summer months at all monitoring stations in Alberta. During the late spring and summer, ozone production in the lower atmosphere is at a maximum due to a peak in incoming sunlight combined with stagnant weather conditions which may cause reactive pollutants to remain in the

region for a prolonged period of time. Transport of ozone from rural areas usually is the cause of elevated ozone levels in Edmonton and Calgary. During the early spring, high daily average ozone values may be influenced by transport of ozone from the upper atmosphere.

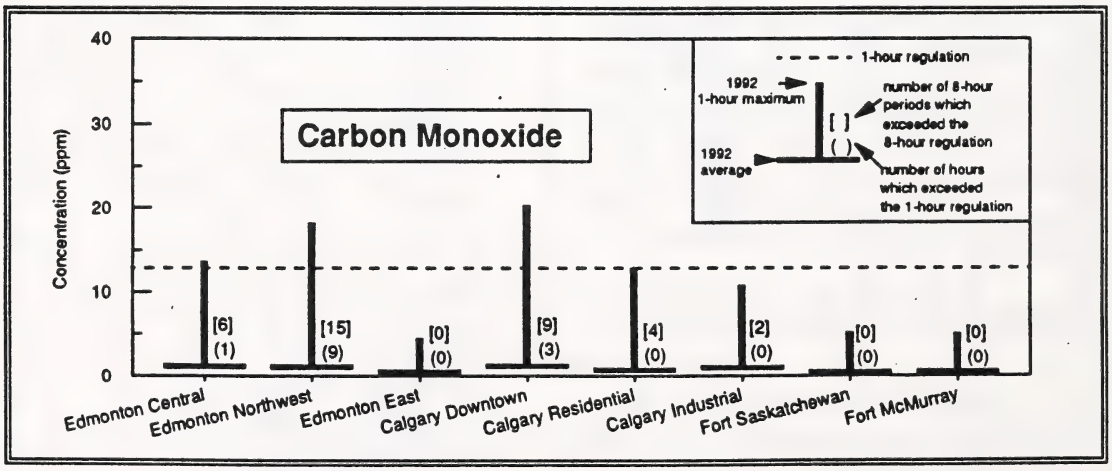
Carbon Monoxide (CO)

Carbon monoxide is a colourless, odourless gas emitted into the atmosphere primarily by motor vehicles. Minor sources include fireplaces, industry, aircraft and natural gas combustion.

In regulating carbon monoxide, Alberta has adopted Environment Canada's most rigorous ambient air quality regulations. Maximum permissible carbon monoxide concentrations are:

- *13.0 ppm as a 1-hour average concentration; and*
- *5.0 ppm as an 8-hour average concentration.*

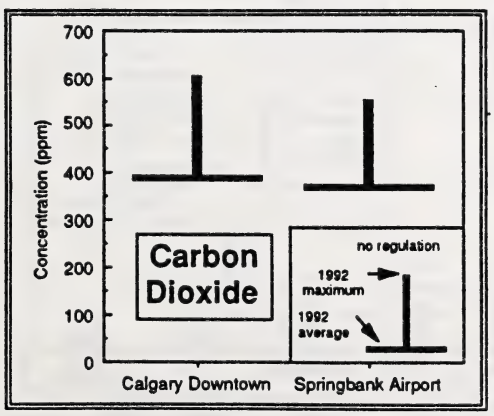
The 1-hour regulation for carbon monoxide was exceeded at the Edmonton central (one hour), Edmonton northwest (nine hours) and Calgary downtown (three hours) monitoring stations in 1992. The 8-hour regulation was exceeded at the Edmonton central (six times) and northwest (15 times) monitoring stations, and the Calgary downtown (nine times), residential (four times) and industrial (two times) monitoring stations. The majority of exceedances of the 1- and 8-hour regulations occurred during the months of January, February, November and December. The major factors which caused these exceedances were the combination of vehicle exhaust emissions and stagnant weather conditions which do not allow pollutants to disperse rapidly. Concentrations of carbon monoxide were generally at a maximum during the morning and afternoon rush hours. This pattern is especially apparent at the downtown monitoring locations in Edmonton and Calgary.



Carbon Dioxide (CO_2)

Carbon dioxide is a colourless, odourless, non-toxic gas that is produced by man through the combustion of fossil fuels. Major natural sources of carbon dioxide include the respiration processes of micro-organisms and plants. Carbon dioxide emissions comprise over half of the greenhouse gases emitted by man. At the present time, regulations do not exist for ambient levels of carbon dioxide.

Alberta Environmental Protection began monitoring carbon dioxide in downtown Calgary in March, 1991 and at Springbank (20 km west-northwest of downtown Calgary) in August, 1991. Average concentrations of carbon dioxide at the Calgary downtown and Springbank stations were 391 and 371 ppm, respectively. These values are higher than annual average concentrations recorded at Crossfield (40 km north of Calgary) from November, 1985 to October, 1987 which ranged from 345 to 348 ppm. Higher carbon dioxide concentrations in downtown Calgary are related to fossil fuel combustion in Calgary.



Coefficient of Haze (COH)

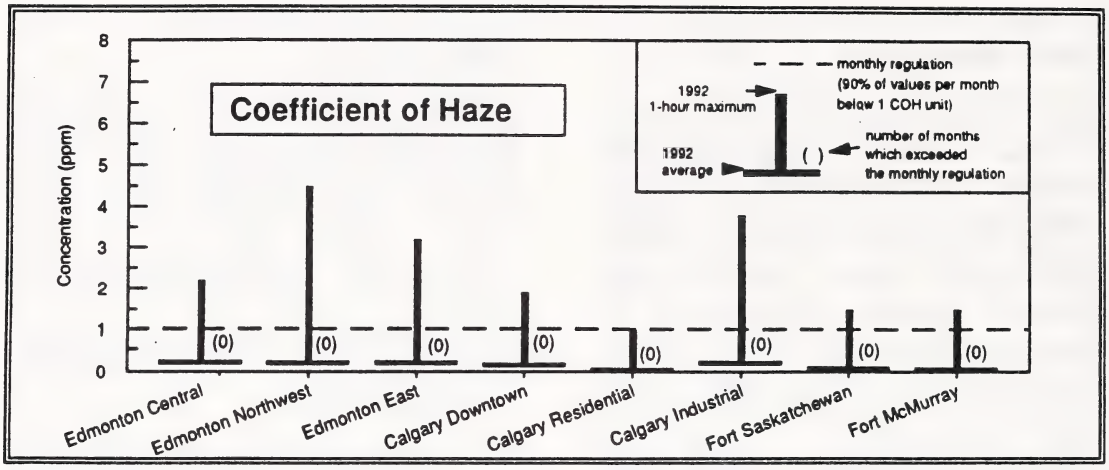
The coefficient of haze is a measurement of the degree of dust and smoke in the atmosphere. Dust and smoke may originate from road dust, wind-blown soil, industrial sources, vehicle emissions, agricultural activities, open burning and various other sources. The guideline for the coefficient of haze, which is based on visibility, established by Alberta Environmental Protection is that:

- *90% of the readings per month shall be less than 1.0 COH unit.*

The guideline for the coefficient of haze (90% of values per month less than 1.0 COH unit) was not exceeded at any monitoring stations in 1992. Coefficient of haze values were much higher at urban stations in Edmonton and Calgary than at the more rural Fort Saskatchewan and Fort McMurray monitoring stations. High dust and smoke values lead to the occurrence of a Very Poor air quality episode on September 29 at the Edmonton northwest station. Coefficient of haze values were typically greatest during the fall and winter when meteorological conditions inhibit pollutant dispersion. Higher values were also apparent during the morning and afternoon rush hours. This is indicative of vehicular movement which contributes to dust and smoke in the atmosphere.

Nitrogen Dioxide (NO_2)

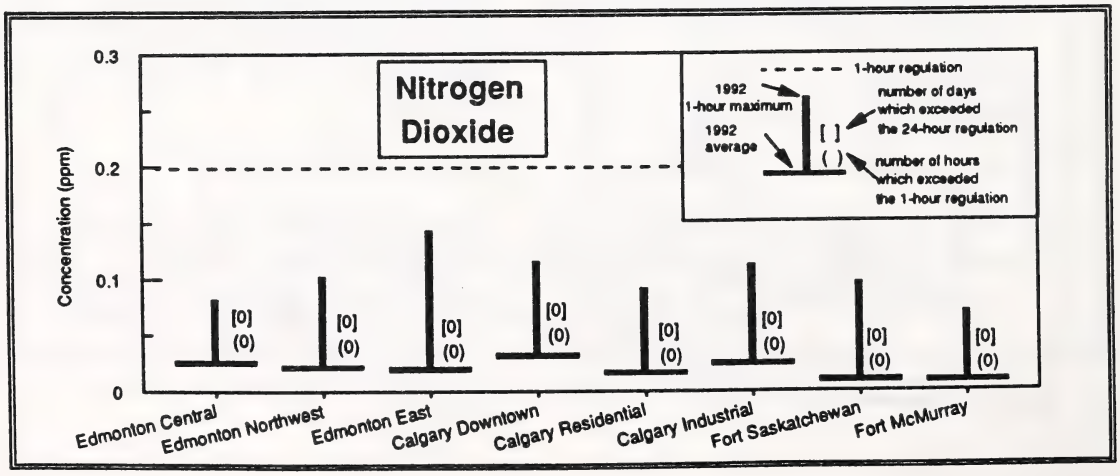
Nitrogen dioxide is a reddish-brown gas with a pungent odour which is partially responsible for the brownish discolouration of the lower atmosphere in urban locations. In Alberta, about 38% of nitrogen dioxide emissions are produced by the oil and gas



industry while 29% are due to transportation (aircraft and vehicles) and 16% due to power plants. Smaller sources of nitrogen dioxide include natural gas combustion, heating fuel combustion, and forest fires. The largest urban source of nitrogen dioxide is emissions from motor vehicles. Regulations for nitrogen dioxide are based on human health effects. The regulations are:

- *0.21 ppm as a 1-hour average concentration;*
- *0.11 ppm as a 24-hour average concentration; and*
- *0.03 ppm as an annual average concentration.*

The 1-hour and 24-hour regulations for nitrogen dioxide were not exceeded at any Alberta Environmental Protection stations in 1992. However, as in previous years, the annual average regulation of 0.030 ppm was exceeded at the Calgary downtown station. An annual average nitrogen dioxide concentration of 0.032 ppm was recorded at this location. The highest nitrogen dioxide concentrations were generally observed at the Calgary downtown, Edmonton central, Edmonton northwest and Calgary industrial stations. Sources of nitrogen dioxide in these areas are emissions from vehicle exhaust and heating fuel consumption.



Maximum nitrogen dioxide concentrations are observed in the winter. This is likely due to vehicular exhaust emissions combined with persistent stable weather conditions. As with carbon monoxide and the coefficient of haze, nitrogen dioxide peaks are evident during the morning and afternoon traffic rush hours.

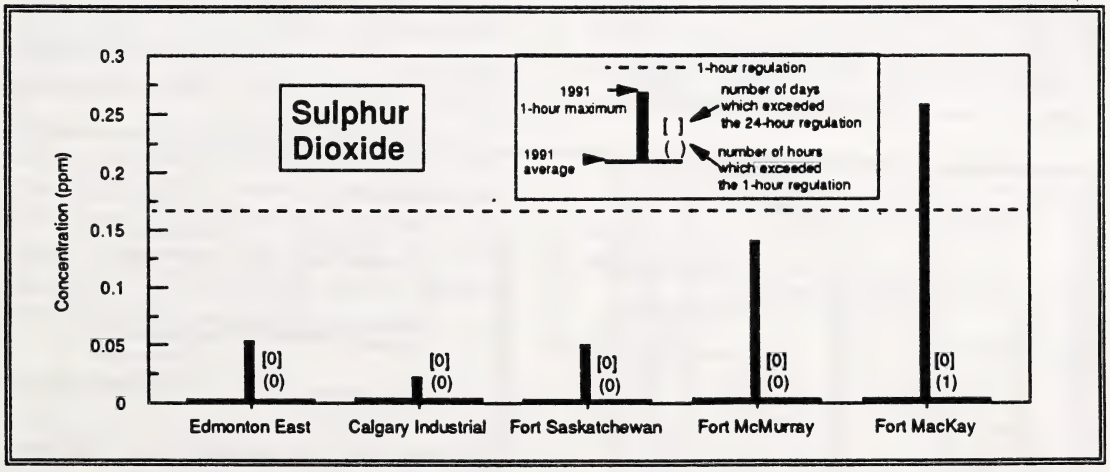
Sulphur Dioxide (SO_2)

Sulphur dioxide is a colourless gas with a pungent odour. In Alberta, it is estimated that 38% of sulphur dioxide emissions are emitted by sulphur extraction plants while oil sands and power plants produce about 29% and 16% of sulphur dioxide emissions, respectively. Other sources include gas plant flares, oil refineries, pulp and paper mills and fertilizer plants.

Alberta Environmental Protection has adopted Environment Canada's most rigorous regulations for sulphur dioxide. The following regulations are based on prevention of effects to vegetation:

- *0.17 ppm as a 1-hour average concentration;*
- *0.06 ppm as a 24-hour average concentration; and*
- *0.01 ppm as an annual average concentration.*

One exceedance of the 1-hour regulation for sulphur dioxide was recorded at the Fort MacKay monitoring station in 1992. A peak 1-hour average value of 0.258 ppm was observed at this station. This value is one and a half times the regulation of 0.17 ppm. Elevated sulphur dioxide readings at this location were due to emissions from the oil sands processing plants located south of Fort MacKay. The regulations for sulphur dioxide were not exceeded at any other monitoring stations.



Hydrogen Sulphide (H_2S)

Hydrogen sulphide is a colourless gas with a rotten egg odour. Industrial sources include petroleum refineries, natural gas plants, petrochemical plants, coke oven plants, and pulp and paper plants which use the kraft pulping process. Natural sources of hydrogen sulphide include sulphur hot springs, sloughs, swamps and lakes.

Regulations for hydrogen sulphide are based on the odour threshold; however, many individuals can smell hydrogen sulphide at levels lower than the ambient regulation. The regulations for hydrogen sulphide in Alberta are:

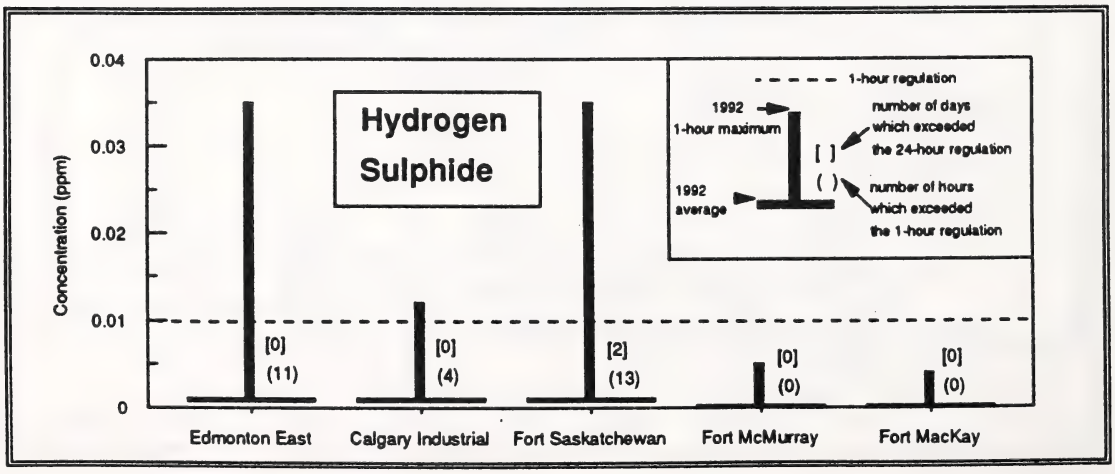
- *0.010 ppm as a 1-hour average concentration; and*
- *0.003 ppm as a 24-hour average concentration.*

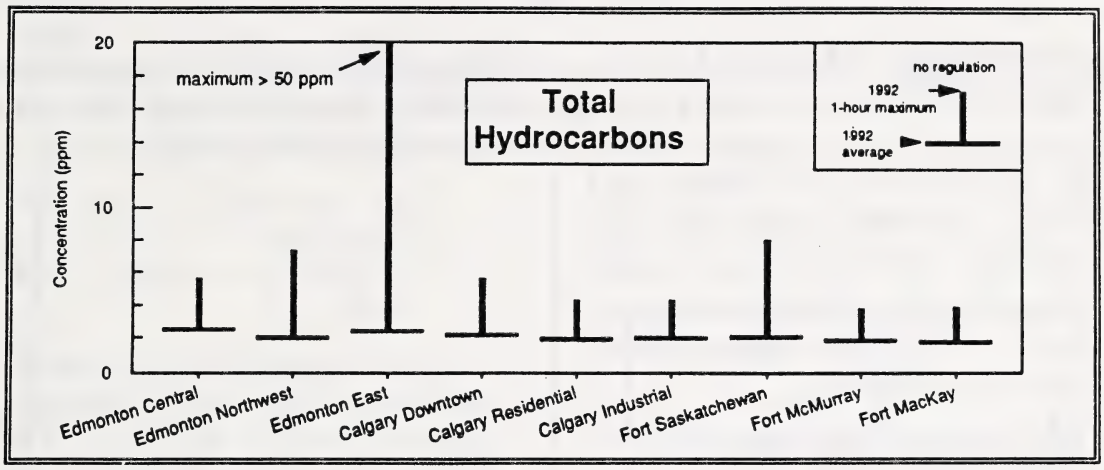
A total of 11 exceedances of the 1-hour regulation for hydrogen sulphide were reported at the Edmonton east monitoring station in 1992. This is compared to 59 exceedances at this location in 1991. The 1-hour regulation was also exceeded at the Calgary industrial (four hours) and Fort Saskatchewan (13 hours) monitoring stations. The 24-hour regulation was exceeded two times at the Fort Saskatchewan station. Exceedances of these regulations were likely caused by fugitive emissions from industrial sources and sewage treatment facilities in the vicinity of the Edmonton east and Calgary industrial stations and from local industry at the Fort Saskatchewan station.

Total Hydrocarbons (THC)

The term "total hydrocarbons" refers to methane and reactive hydrocarbons. Reactive hydrocarbons (or volatile organic compounds) may react with sunlight to form ozone. Sources of hydrocarbons include vegetation, vehicular emissions, gasoline marketing and storage tanks, petroleum and chemical industries, drycleaning, fireplaces, natural gas combustion and aircraft traffic.

The highest annual average total hydrocarbon values were observed at the Edmonton central and east monitoring stations. A maximum hydrocarbon value of greater than 50 ppm (the upper scale of the monitoring instrument) was recorded in June at the east Edmonton monitoring station. Hydrocarbon concentrations at this station were significantly less than those observed in 1991. The highest 1-hour average total





hydrocarbon concentration recorded at a location other than east Edmonton occurred at Fort Saskatchewan where a value of 8.0 ppm was recorded. Elevated hydrocarbons concentrations in east Edmonton and Fort Saskatchewan were due to fugitive emissions from industrial sources and vehicular emissions. Vehicular emissions were the major source of hydrocarbons in downtown Edmonton and Calgary. Normal background total hydrocarbon concentrations are about 1.5 ppm.

Hydrocarbon concentrations were the highest in the winter months at monitoring stations which are located close to major traffic arteries. In downtown Edmonton and Calgary, maximum hydrocarbon values were observed during the morning and afternoon rush hours. This shows that vehicles are the major source of hydrocarbons at urban locations. No regulations exist for ambient total hydrocarbon concentrations.

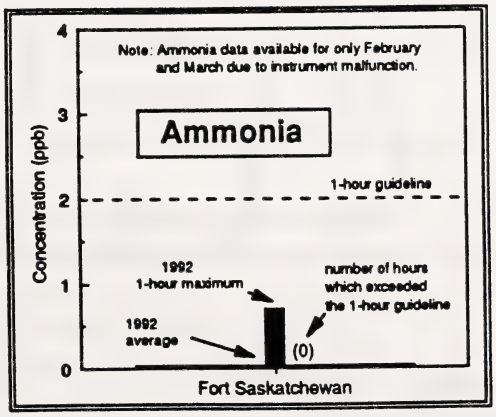
Ammonia (NH_3)

Ammonia is a colourless gas with a pungent odour. Ammonia is emitted into the atmosphere through natural sources such as animal decay and animal excretions, and man-made sources such as the fertilizer industry.

The guideline for maximum permissible ammonia concentrations is:

- *2.0 ppm as a 1-hour average concentration.*

Ammonia is monitored at Fort Saskatchewan because of its proximity to the fertilizer industry. In 1992, ammonia was monitored only in February and March due to instrument malfunction and relocation of the station. The overall maximum ammonia concentration at the Fort Saskatchewan station was 0.7 ppm. Ammonia concentrations were below the limit of detection over 90% of the time during the monitoring period.



INTERMITTENT AIR QUALITY MONITORING

Intermittent air quality monitoring refers to air pollutants which are monitored as a 24-hour accumulated loading, once every sixth day, in accordance with the National Air Pollution Surveillance (NAPS) monitoring scheme. Suspended particulates, Benzo (a) Pyrene and lead are monitored according to this system.

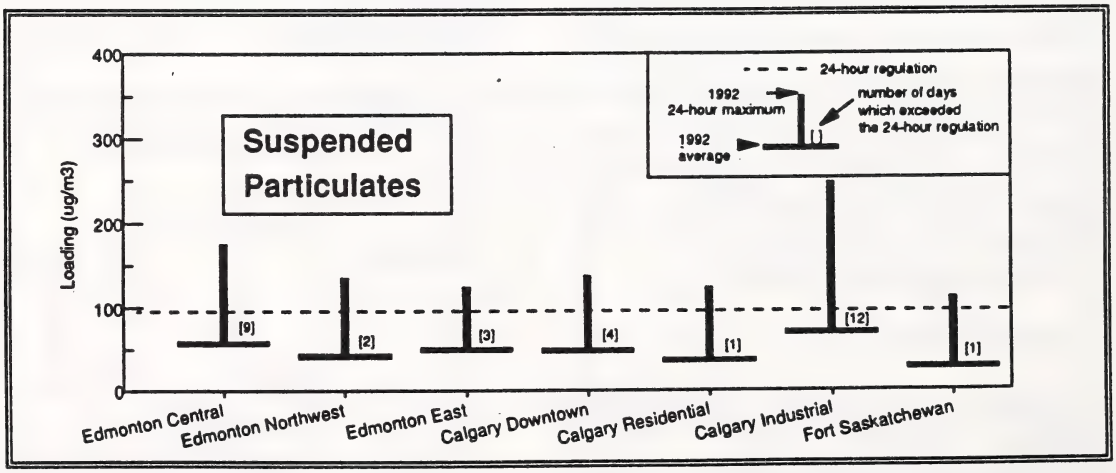
Total Suspended Particulates (TSP)

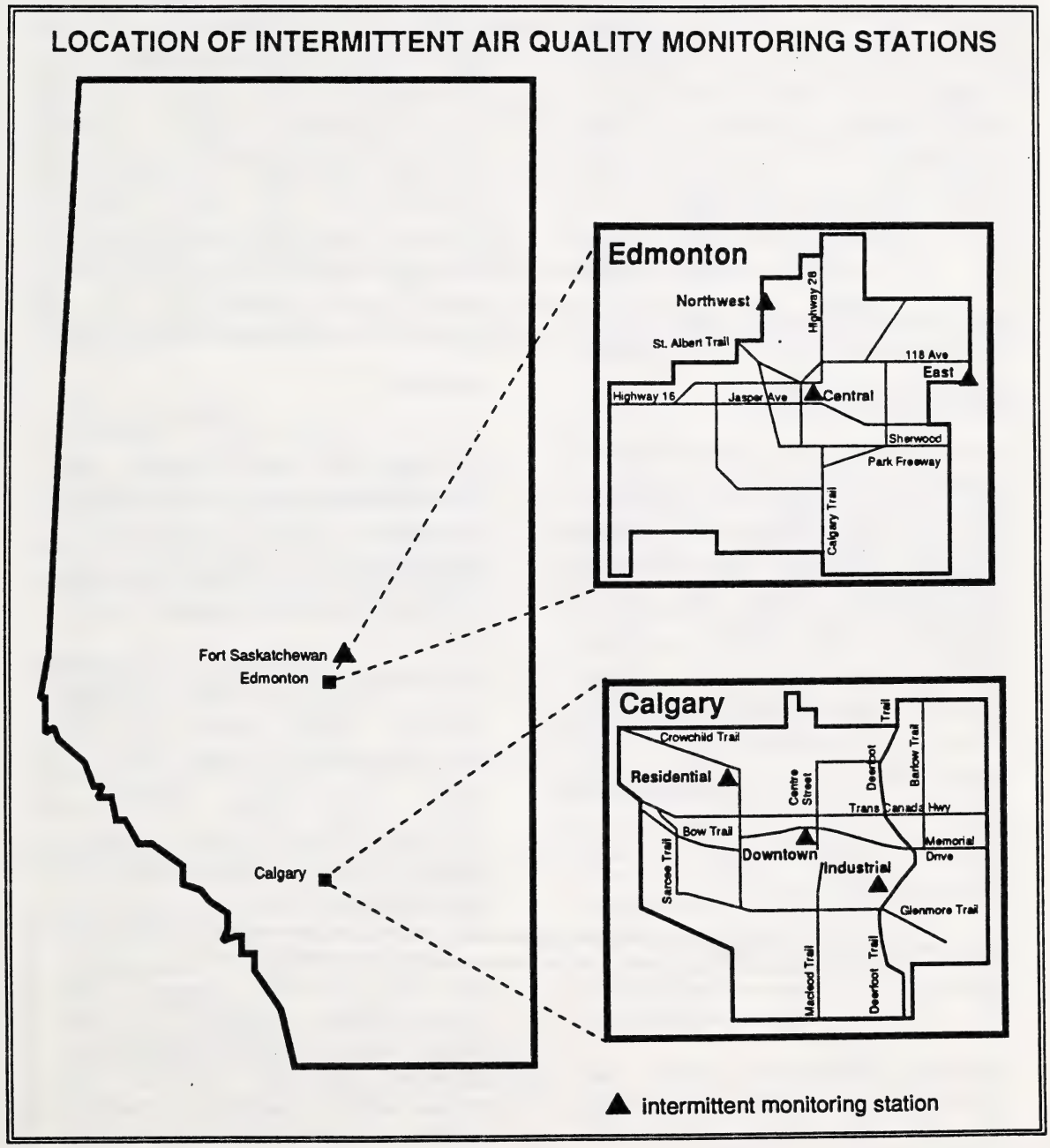
Suspended particulates are particles which range from about 0.001 to 500 microns in diameter (a human hair is about 100 microns in diameter) and, depending on their density, may remain suspended in the air for an indefinite period of time. Suspended particulates may originate from soil, road and agricultural dust; smoke from forest fires and recreational fires; vehicular exhaust emissions; and industrial sources.

The regulations for total suspended particulates are based on nuisance effects and visibility reduction. Alberta Environmental Protection has adopted the following federal standards for total suspended particulate loadings:

- *100 ug/m^3 as a 24-hour total loading; and*
- *60 ug/m^3 as an annual average loading.*

The 24-hour regulation for total suspended particulates was exceeded at all suspended particulate stations in 1992. The highest number of exceedances was at the Calgary industrial station where the regulation was exceeded twelve times. This is compared to 18 exceedances recorded at the Calgary industrial location in 1991. The annual average regulation was also exceeded at the Calgary industrial monitoring station where a value of 70.7 ug/m^3 was recorded. Sources of suspended particulates at the Calgary industrial and Edmonton east stations were vehicle traffic and industrial emissions. The major source of suspended particulates in downtown Edmonton and Calgary was vehicle traffic.





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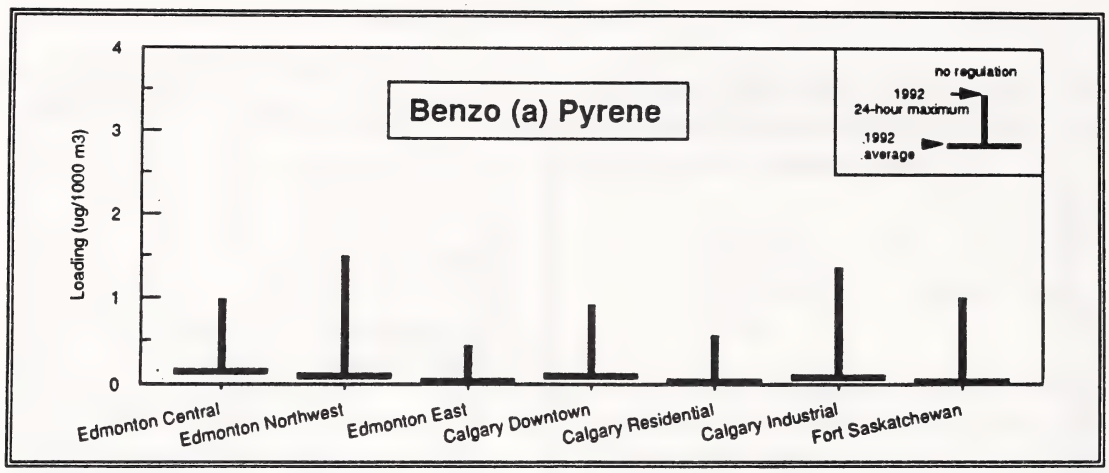


Benzo (a) Pyrene (BaP)

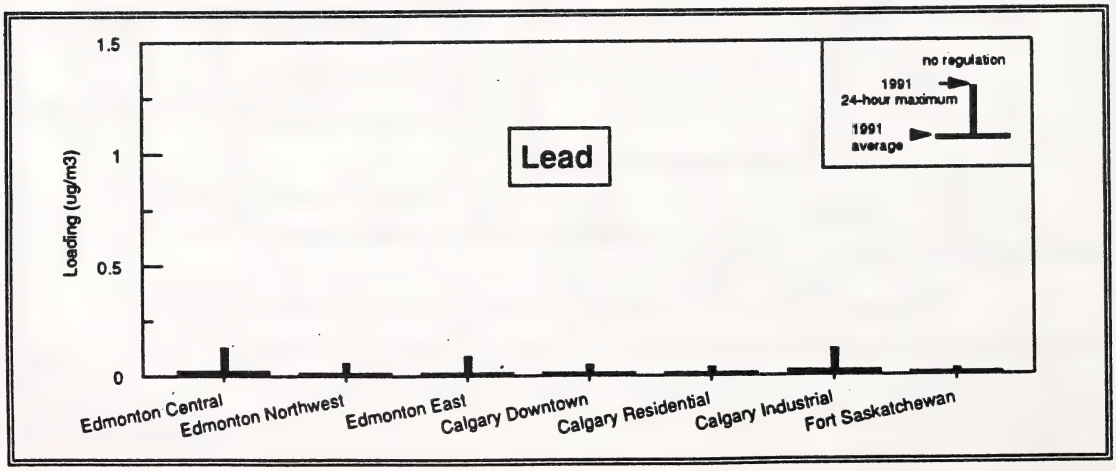
Benzo (a) Pyrene is a polycyclic aromatic hydrocarbon (PAH) that is contained in all types of soot and smoke. Vehicular exhaust, and smoke from industrial and recreational emissions are the most common sources of Benzo (a) Pyrene. No air quality regulations currently exist in Alberta for Benzo (a) Pyrene.

Benzo (a) Pyrene loadings were significantly higher at monitoring stations located close to major traffic arteries (i.e. Edmonton central, Edmonton northwest, Calgary downtown and Calgary industrial). The major source of Benzo (a) Pyrene at these locations is vehicular emissions.

Lead (Pb)

Lead is emitted into the atmosphere primarily as a result of burning leaded gasoline in motor vehicles. Other sources of atmospheric lead include iron and steel manufacturing, solid waste incineration and battery manufacturing. There are no ambient regulations for lead in Alberta.

Lead loadings were low at all monitoring stations. The Edmonton central and Calgary industrial stations recorded the highest annual average lead loadings in 1992 (0.02 ug/m^3). This compares with a maximum annual average loading of 0.05 ug/m^3 recorded in 1991. Lead loadings were higher at stations located close to major traffic arteries.



STATIC AIR QUALITY MONITORING

Alberta Environmental Protection conducts air quality monitoring, on a static basis, at 51 networks throughout Alberta. Each network consists of at least one monitoring station. Static monitoring is the measurement of total accumulated loadings of pollutants on a one- and three-month schedule. This type of air quality monitoring is useful as a simple, inexpensive indicator of trends. Parameters monitored on a static basis include total sulphation, hydrogen sulphide, dustfall, calcium and fluorides.

Total Sulphation

Total sulphation is the measurement of sulphur-containing compounds which exist in the atmosphere. Sulphur recovery gas plants, coal-burning power plants and petroleum refining plants are common sources of these gases.

The guideline for total sulphation loading in Alberta is:

- *0.50 mg SO_3 equivalent/day/ 100 sq cm.*

The highest annual average total sulphation values were recorded at the Diamond Valley and Redwater networks in 1992. One exceedance of the guideline for total sulphation was recorded at the Diamond Valley network. Relatively high annual average total sulphation loadings were also recorded at the Fort Saskatchewan, Waterton and Coleman monitoring networks. Relatively high loadings at these locations were likely caused by industrial activity in the region.

Hydrogen Sulphide

Hydrogen sulphide is present in the atmosphere from natural sources such as coal, natural gas, oil, sulphur hot springs, sloughs, swamps and lakes. Industrial sources of hydrogen sulphide include petroleum refining plants, natural gas plants, petrochemical complexes, coke oven plants, pulp and paper plants employing the kraft pulping process, and petroleum and gas gathering fields.

The guideline for hydrogen sulphide loading in Alberta is:

- *0.10 mg SO_3 equivalent/day/ 100 sq cm.*

Exceedances of the guideline for hydrogen sulphide did not occur at any static monitoring networks in 1992. The highest annual average hydrogen sulphide loadings were observed at the Fort McMurray, Fort Saskatchewan, Sherwood Park and Redwater networks. Industrial activities in the region are the most likely sources of relatively high values at these locations.

Total Dustfall

Dustfall is particulate matter which is too heavy to remain suspended in the atmosphere indefinitely. Sources of dustfall include wind-blown soil, road dust, dust generated by agricultural activities, ash from forest fires and recreational fires, and flyash from industrial sources.

The Alberta Environmental Protection regulations for total dustfall loadings are:

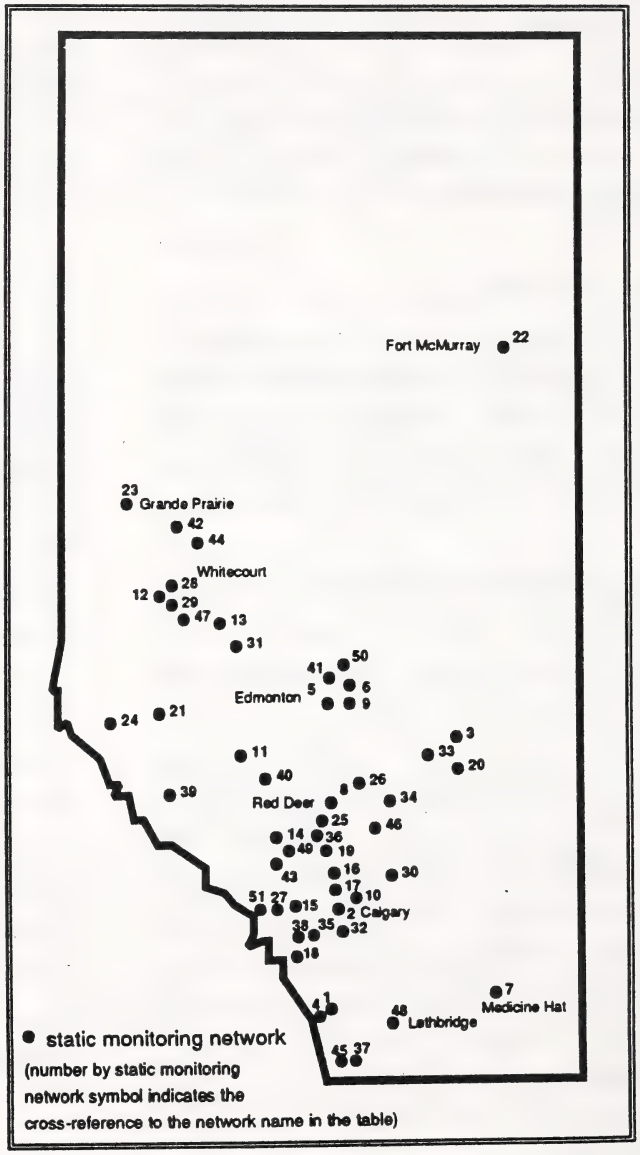
- *53 mg/100 sq cm/30 days in residential and recreational areas;*
- *158 mg/100 sq cm/30 days in commercial and industrial areas;*

LOCATION OF STATIC AIR QUALITY MONITORING NETWORKS

Map Location	Network Location
1	Blairmore
2	Calgary
3	Camrose
4	Coleman
5	Edmonton
6	Fort Saskatchewan
7	Medicine Hat
8	Red Deer
9	Sherwood Park
10	Balzac
11	Buck Lake
12	Bigstone
13	Blue Ridge
14	Caroline
15	Cochrane
16	Carstairs
17	Crossfield
18	Diamond Valley
19	Didsbury
20	Edburg
21	Edson
22	Fort McMurray
23	Grande Prairie
24	Hinton
25	Innisfail
26	Joffre
27	Jumping Pound
28	Kaybob
29	Kaybob (south)
30	Lone Pine Creek
31	Mayerthorpe
32	Mazeppa
33	New Norway
34	Nevis
35	Okotoks
36	Olds
37	Pincher Creek
38	Quirk Creek
39	Ram River
40	Rimbey
41	St. Albert
42	Simonette
43	Sundre
44	Valleyview
45	Waterton

Map Location	Network Location
46	Wimborne
47	Windfall
48	Lethbridge

Map Location	Network Location
49	Raven Brood
50	Redwater
51	Exshaw



Total dustfall loadings exceeded Alberta Environmental Protection regulations for residential regions at most networks where total dustfall is monitored. Regulations for industrial regions were exceeded at eight of these networks. The highest frequency of exceedances of the residential and industrial regulations for dustfall occurred at the Lethbridge network where these regulations were exceeded 92 and 50% of the time, respectively. The major sources of dustfall in Alberta include road dust, agricultural dust, dust from industrial sources, and vehicular exhaust.

Calcium

Calcium emanates from natural sources such as wind-blown soil and road dust. Man-made sources of calcium in dustfall include cement, iron, steel and wood processing. There are no regulations or guidelines for atmospheric loadings of calcium in Alberta.

As in previous years, the highest annual average calcium loading was recorded at the Exshaw network where a loading of 5.0 milligrams per 100 square centimeters per 30 days was reported. This value is almost two times higher than the calcium loadings recorded in the Edmonton area. Relatively high calcium loadings in the Exshaw region may be attributed to cement manufacturing activities in the area.

Fluorides

Fluorides are emitted into the atmosphere through processes such as coal combustion and the processing of phosphate bearing rock.

The Alberta Environmental Protection guideline for fluoride loading is:

- *40.0 ug water soluble fluorides/100 sq cm/30 days*

Fluoride loadings were the highest at the Redwater monitoring network with an annual average loading of 2.8 micrograms per 100 square centimeters per 30 days. The guideline for fluorides was not exceeded at any monitoring stations. A maximum fluoride loading of 11.3 ug/100 sq cm/30 days was recorded at the Redwater network. This value is 28% of the guideline for fluorides.

ACID PRECIPITATION MONITORING

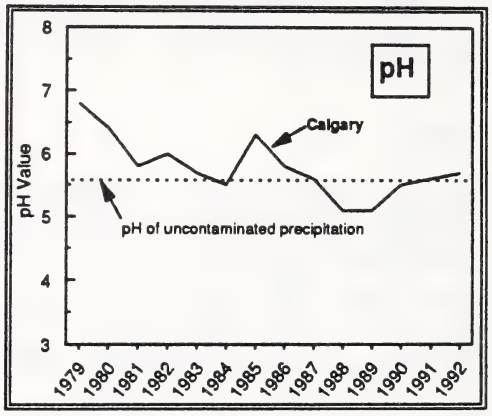
Rain and snow samples were collected, on a monthly basis from January to August and on a weekly basis from September to December, at 12 locations in the province by Alberta Environmental Protection in 1992. Chemical analysis was conducted on these samples to obtain pH as well as other ions contained in precipitation. The effective acidity of the precipitation was also calculated. Target loadings for acid precipitation are currently being developed by Alberta Environmental Protection.

pH

In 1992, the most acidic (lowest pH) precipitation was recorded at the Fort McMurray precipitation monitoring station where an annual average pH value of 4.7 was observed. Relatively low annual average pH values were also measured at Beaverlodge, Cold Lake, High Prairie, Fort Chipewyan, Fort Vermilion, Red Deer and Kananaskis (pH of 5.2 or less). The Calgary and Suffield precipitation stations recorded annual average pH values close to that of uncontaminated precipitation (pH of 5.6). Annual pH values higher than 5.7 were not recorded at any monitoring stations in 1992.

Based on an analysis of precipitation samples collected from 1978 to 1990, average pH values ranged from 5.0 at Fort Chipewyan to 6.1 at High Prairie. Beaverlodge, Cold Lake, Fort McMurray, and Kananaskis recorded average pH values of 5.2 or less for this period. The average pH of precipitation on a province wide basis was 5.5, close to that of uncontaminated precipitation.

A significant decrease in pH values is evident at several monitoring sites. This decrease is most apparent at the Calgary precipitation station. Lower pH values (or increased acidity) may be caused by: improved sampling techniques (i.e. less wind blown dust in the sample); increased emissions of oxides of nitrogen and sulphur dioxide in the vicinity of the station; or a change in the location of the monitoring site.



Anions (sulphate, nitrate, chloride, phosphate)

Anions in precipitation may result from emissions into the atmosphere from coal-fired power plants, oil refineries, gas plants, oil sands plants, pulp and paper plants, fertilizer plants, vehicular emissions and agricultural activities. Alberta Environmental Protection does not have regulations for anions in precipitation.

The highest wet sulphate deposition rates were recorded at the Calgary and Kananaskis stations where values of 6.0 and 5.5 kg/ha/yr (kilograms per hectare per year) were observed, respectively. These values are substantially lower than the eastern Canada objective of 20 kg/ha/yr.

Maximum wet nitrate deposition rates were observed at Kananaskis (3.5 kg/ha/yr), Calgary (3.1 kg/ha/yr) and Red Deer (3.0 kg/ha/yr). A maximum wet chloride deposition rate of 1.5 kg/ha/yr was observed at Fort Chipewyan. Wet phosphate deposition was relatively low at all monitoring stations.

Cations (calcium, ammonium, sodium, magnesium, potassium)

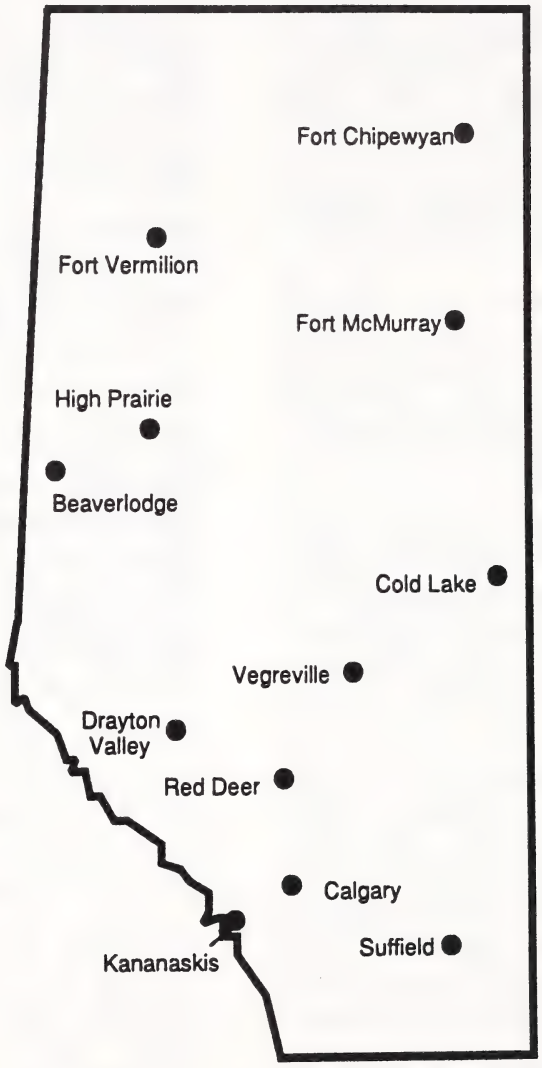
Cations may originate from industrial sources such as iron and steel manufacturing, wood processing, or natural sources such as wind-blown soil and dust. There are currently no regulations for cations in precipitation in Alberta.

Maximum wet ammonium deposition values were recorded at the Calgary station where a value of 3.7 kg/ha/yr was observed. Wet calcium deposition rates of 1.5 kg/ha/yr or greater were recorded at Fort Chipewyan, Calgary and Kananaskis. Wet sodium and magnesium deposition rates were at or below 0.5 kg/ha/yr at all precipitation monitoring stations. Wet potassium deposition rates were also below 0.5 kg/ha/yr at most stations with the exception of Fort Chipewyan where a value of 1.0 kg/ha/yr was recorded.

Effective Acidity

Effective acidity is an approach which has been developed to estimate the amount of acidity produced in soil due to physical, chemical and biological processes which occur as a result of acid rain and snow. The highest calculated annual effective acidity rate occurred at Calgary where a value of 0.21 kg/ha/yr of H^+ (hydrogen ion equivalents) was estimated. Effective acidity rates at the remaining monitoring stations ranged from 0.03 to 0.08 kg/ha/yr of H^+. The proposed range for effective acidity limits is 0.1 to 0.3 kg/ha/yr of H^+ for sensitive soils.

LOCATION OF ACID PRECIPITATION MONITORING STATIONS



● acid precipitation monitoring station

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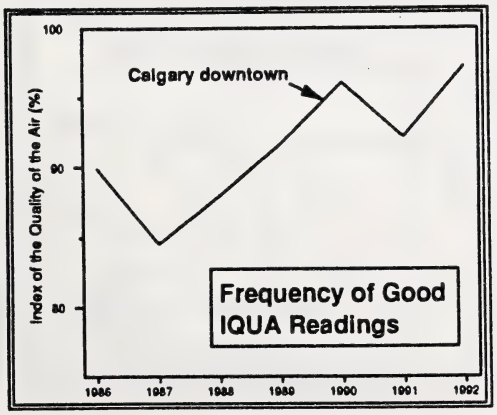
Environmental Quality Monitoring Branch

AIR QUALITY TRENDS

The long-term trend of air pollution levels is an important indicator of changes in air quality. Approximately 17 years of data are available for ozone, carbon monoxide, the coefficient of haze, nitrogen dioxide and total hydrocarbons. Suspended particulate and lead data are available for a 13 year period while 11 years of Benzo (a) Pyrene data are available at most stations. Annual average concentrations for ammonia, hydrogen sulphide and sulphur dioxide are not high enough to resolve significant trends. Not enough data is available for carbon dioxide to determine annual average trends.

Index of the Quality of the Air

A trend towards more frequent Good air quality ratings at the Calgary downtown station is visible based on seven years of data (1986 to 1992). In 1992, Good air quality ratings were more frequent than the seven year average at all Calgary, Fort McMurray and Fort Saskatchewan stations. The frequency of Good air quality at the Edmonton east station in 1992 was slightly less (2.5%) than the seven year average value.

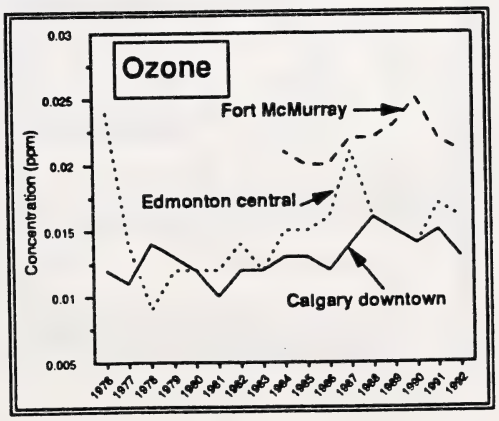


Ozone

Ozone is formed in the lower atmosphere through the reaction of sunlight with oxides of nitrogen and volatile organic compounds (VOCs). The transport of ozone from the upper atmosphere to ground level may also be an important contributor to ozone levels in the lower atmosphere. At urban locations in Alberta, ozone is often destroyed by nitric oxide emitted by automobiles.

A small upward trend in annual average ozone concentrations is evident from data collected at the Edmonton central, Calgary downtown and Fort McMurray monitoring stations. However, annual average ozone concentrations have decreased at Fort McMurray since 1990. Upward trends in ozone may be caused by a number of contributing factors including: (1) increased concentrations of oxides of nitrogen and VOCs which react with sunlight at warm temperatures to form ozone; (2) increased transport of ozone from the upper atmosphere to ground level; or (3) decreased levels of nitric oxide from motor vehicles at these locations. The portion that each of these factors contribute to ozone concentrations cannot be directly determined.

In 1992, annual average ozone values were close to the long-term average at most stations. The Calgary residential and Fort Saskatchewan stations recorded annual average values that were slightly below the long-term average concentrations.



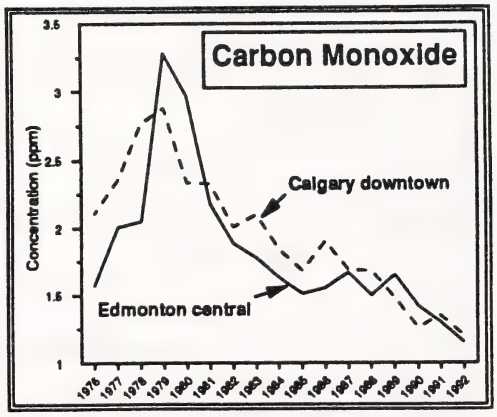
Carbon Monoxide

The major source of carbon monoxide in urban areas is vehicular emissions. Other sources include industrial emissions, aircraft emissions, fireplaces and natural gas combustion.

Based on annual average concentrations, a downward trend in carbon monoxide is evident at the Edmonton central and northwest stations, all Calgary stations, and the Fort McMurray station. Lower carbon monoxide concentrations at these stations can be attributed to more efficient automobile engines and emission control devices.

A peak in annual average carbon monoxide concentrations was evident in 1979 at most monitoring stations. This peak may reflect the boom in the economy which occurred in the late 1970s (i.e. more building construction and an increase in vehicular activity).

With the exception of Fort McMurray, all stations reported annual average carbon monoxide concentrations in 1992 that were significantly lower than the long-term average. At Fort McMurray, a slightly higher annual average carbon monoxide concentration was reported in 1992.

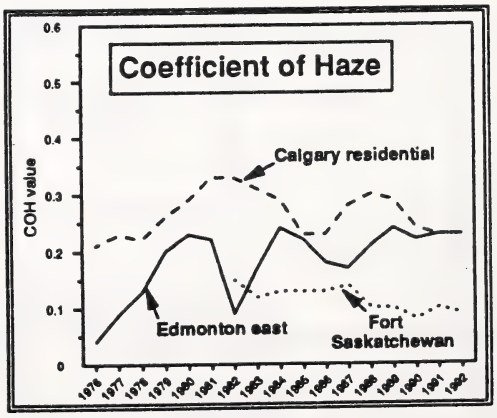


Coefficient of Haze

The coefficient of haze is a measurement of dust and smoke resulting from sources such as road dust, wind-blown soil, industrial emissions, automobiles, agricultural activities, open burning and fireplaces.

A small increase in annual average coefficient of haze values is indicated at the Edmonton east location. This trend may be due to the combination of a greater traffic density in east Edmonton and increased industrial emissions in the region. A slight downward trend in coefficient of haze values is evident at the Calgary residential and Fort Saskatchewan stations. This decrease may be associated with cleaner streets in the vicinity of these stations.

With the exception of the Edmonton east location, annual average coefficient of haze values recorded in 1992 are close to the same or lower than the long-term average. The annual average coefficient of haze value at the Edmonton east station is about 25% higher than the long-term average.

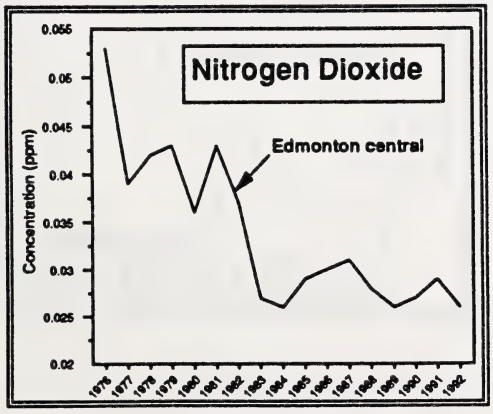


Nitrogen Dioxide

Major sources of nitrogen dioxide include motor vehicle emissions, aircraft emissions, the oil and gas industry, power plants, natural gas combustion and heating fuel combustion.

Nitrogen dioxide shows a significant downward trend, based on 17 years of data, at the Edmonton central monitoring station. Lower concentrations in downtown Edmonton may be due to decreased emissions of oxides of nitrogen from motor vehicles as well as decreased consumption of heating fuel. This trend was most pronounced from 1981 to 1983. Annual average nitrogen dioxide concentrations show little variability after 1983. Nitrogen dioxide levels do not show a trend at other stations.

Annual average nitrogen dioxide concentrations in 1992 were close to the same or lower than the long-term average at all stations except for east Edmonton. The annual average nitrogen dioxide value at the Edmonton east station was 18% higher than the long-term average.

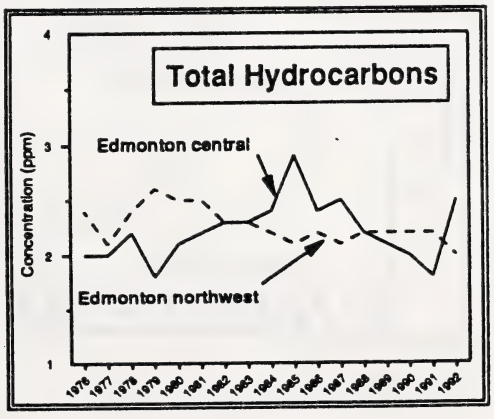


Total Hydrocarbons

Hydrocarbons may be emitted from a variety of sources. Some of these sources are vehicular emissions, the petroleum and chemical industries, and vegetation.

Based on 17 years of data, a slight upward trend in hydrocarbon concentrations is noticeable at the Edmonton central monitoring station. This trend may be related to an increase of vehicular traffic in the vicinity of these stations. A small downward trend in hydrocarbon values is evident at the Edmonton northwest station. Significant trends are not apparent at other monitoring stations.

Annual average hydrocarbon concentrations in 1992 were close to the long-term average at the Edmonton east station, all Calgary stations, and the Fort Saskatchewan and Fort McMurray stations. Annual hydrocarbon values significantly greater than the long-term average were observed in downtown Edmonton and Fort Saskatchewan. A slightly lower than average annual hydrocarbon concentration was reported at the Edmonton northwest station in 1992.

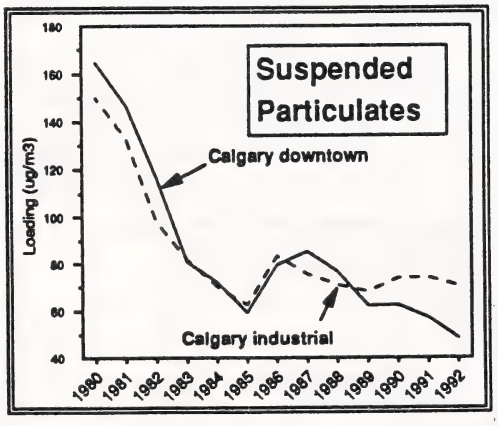


Suspended Particulates

Common sources of particulates in the atmosphere are road dust, wind-blown soil, automobile emissions, industrial emissions, and smoke from recreational and forest fires.

Significant decreases in suspended particulate loadings are indicated at the Edmonton central, Edmonton northwest, Fort Saskatchewan and all Calgary monitoring stations. This trend is most obvious at the Calgary downtown and industrial monitoring stations. The downward trend in suspended particulate loadings may be due to: (1) less road dust because of more paved roads; and (2) more efficient automobile engines.

Annual average suspended particulate loadings observed in 1992 were substantially lower than the long-term average at all stations. The annual average suspended particulate value recorded in downtown Calgary was 43% lower than the long-term average.

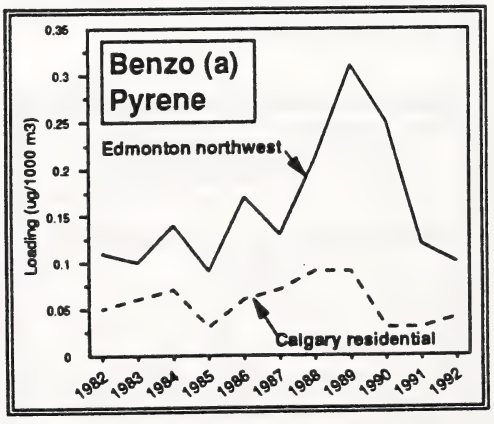


Benzo (a) Pyrene

Benzo (a) Pyrene is contained in all types of smoke. Major sources of Benzo (a) Pyrene include vehicular exhaust, smoke from industrial sources, and smoke from recreational and forest fires.

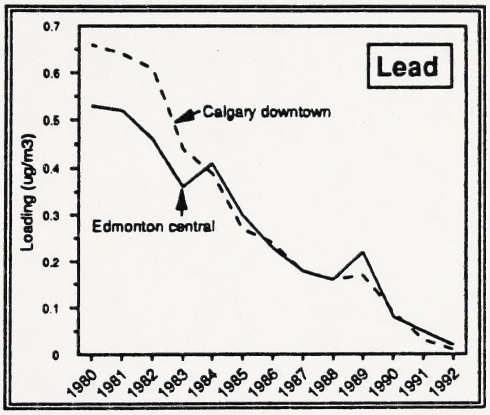
Based on data collected from 1982 to 1989, Benzo (a) Pyrene loadings show a significant increase at the Edmonton northwest and Calgary residential monitoring stations. However, since 1989, Benzo (a) Pyrene loadings show a substantial decrease at most monitoring stations. Lower Benzo (a) Pyrene loadings in recent years may be related to more efficient automobiles.

Annual average Benzo (a) Pyrene loadings in 1992 are close to half of the long-term average at all stations. For example, the annual average at the Calgary industrial station was 38% of the long-term average.



Lead

The major source of lead in the atmosphere is automobile emissions. Other sources of lead include the manufacturing of iron and steel.



Based on lead data collected in Alberta a decrease in annual average lead loadings is evident at all monitoring stations. This trend is most pronounced at the downtown locations in Edmonton and Calgary. The cause of lower lead loadings over the past 13 years is the decrease in the use of leaded gasoline. The suspended sale of leaded gasoline at domestic gas stations is likely the reason for decreased lead loadings from 1990 to 1992.

Annual average lead loadings were close to 10% of the long-term average at all air quality stations. The most significant declines are evident at the monitoring stations located close to major traffic arteries.